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A theoretical model of a colour television display for the assessment of random noise

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Summary

A mathematical model of a colour television display is developed, by means of which the subjective visibility of noise in the display may be computed from a knowledge of the noise-signal components at the three video-signal inputs to the display.

1. Introduction

The three colour-separation signals that are supplied to a colour television display inevitably have noise signals associated with them. If each of these signals is generated independently (for example, if they are obtained directly from the appropriate colour-separation channels of a simple three-tube camera) their noise components will be completely incoherent. Usually, however, signal-processing circuits are interposed between the camera tubes and the picture display; this can result in the noise signal associated with any one picture-display signal being made up of components originating from all channels of the picture-originating equipment. The random fluctuations of light intensity in one of the colour-separation pictures that make up the complete colour display can therefore contain both incoherent and coherent components relative to the fluctuations in the other two colour-separation pictures; furthermore, the sense of the coherent components may be either to reinforce or reduce the overall fluctuation of luminance. Random fluctuations in the chromaticity of the reproduced picture will also occur. Little information appears to be available on the relation between the magnitude of such noise components and their subjective effect on the displayed picture, and the model of the colour display described in this report is an attempt to derive such a relationship.

The representation of a colour television display by electronic circuit elements, as described in Section 2, is based on two assumptions: —

(i) That results obtained for the relationship between the signal-to-noise ratio of a gamma-corrected video signal and the corresponding overall subjective visibility of the noise in a black-and-white television picture are applicable to the case of a colour display.

(ii) That fluctuations in chromaticity may be ignored and account taken only of fluctuations in luminance.

The implications of adopting the second of those two assumptions is discussed in Section 3, where a method of including the effect of fluctuations in chromaticity is suggested.

The representation of the various processes which occur in a colour television display by electronic circuit elements enables the magnitude of a noise signal at any point in the model to be calculated, knowing the noise-signal magnitude at the input and the properties of the circuit elements concerned. As some of these circuit elements are non-linear, knowledge of the video-signal magnitudes at the inputs to the colour display is also required, as the video signal level supplied to a non-linear element determines the operating point on the transfer characteristic of the element and therefore its effective gain. These video-signal magnitudes can be calculated, knowing the chromaticity and luminance assumed to be exhibited by the display. The choice of suitable 'test colours' is discussed in the Appendix to this report.

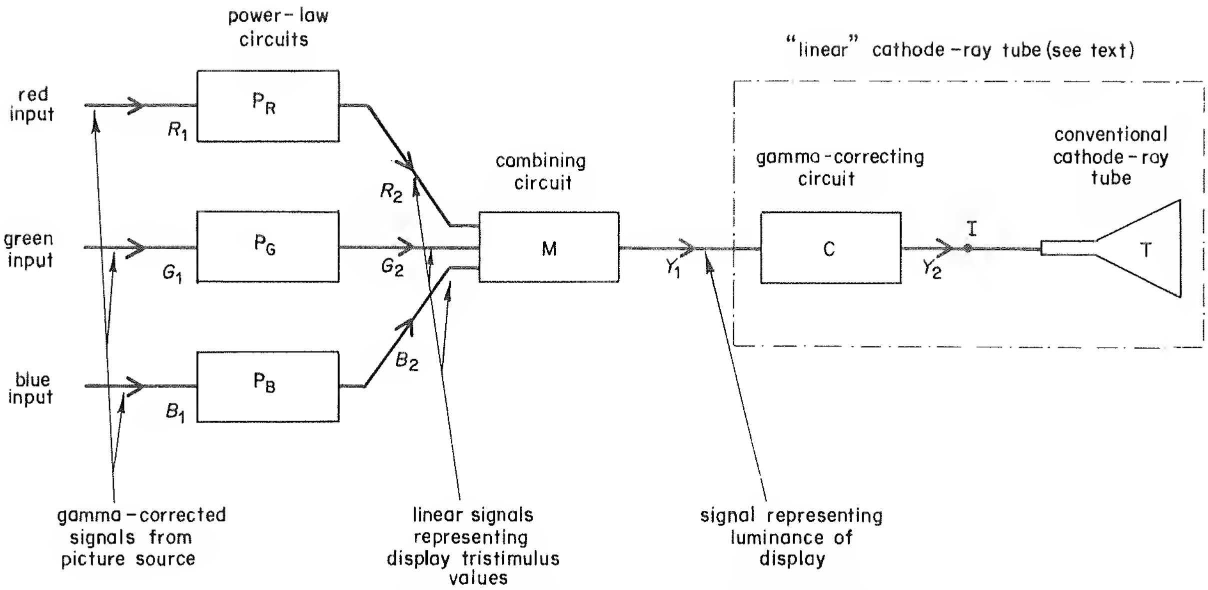

Fig. 1 - Block diagram of model of colour television display

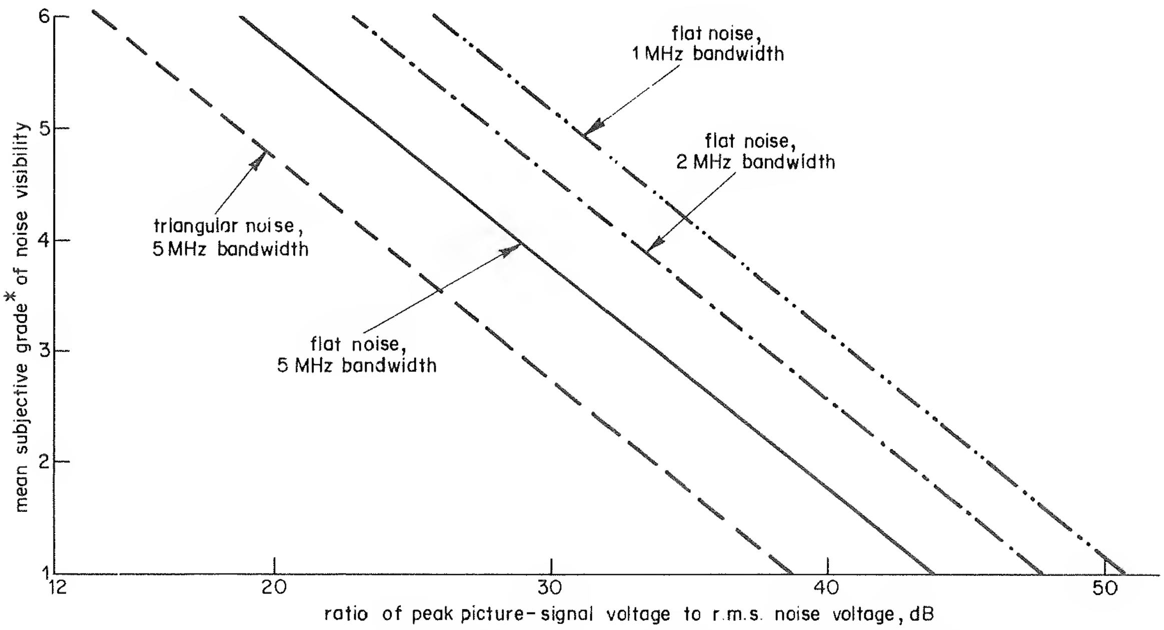

Fig. 2 - Grade of noise visibility as a function of signal-to-noise ratio (after Geddes[1])

* 1. Imperceptible 2. Just perceptible 3. Definitely perceptible but not disturbing 4. Somewhat objectionable 5. Definitely objectionable 6. Unusable

2. Description of model of colour television display

A block diagram of the model of a colour television display is shown in Fig. 1. The components P_R, P_G and P_B are power-law circuits in each input-signal path which represent the transfer characteristic of the display cathode-ray tube (c.r.t.) electron guns: the input to each circuit (R_1, G_1, B_1) represents the electrical signal supplied to each input of the display while the output of each circuit (R_2, G_2, B_2) represents a quantity proportional to the electron-beam current falling on to the appropriate phosphor. The three input signals (R_1, G_1, B_1) and the three output signals (R_2, G_2, B_2) are normalised to unity under conditions in which the display chromaticity and luminance correspond to 'peak white': on the assumption that the light output/beam current characteristics of each phosphor in the display are linear, the output-signal magnitudes become the tristimulus values* for the display chromaticity and luminance under consideration. It is thus possible to calculate the input-signal magnitudes corresponding to each 'test colour' assumed to be adopted by the display.

The luminance of the display for any colour is given by the sum of the individual tristimulus values, each being weighted by a 'luminosity coefficient' which is a function of the primary chromaticity. In the model of the display shown in Fig. 1 this action is represented by the combining circuit M, whose output (Y_1) is related to the inputs R_2, G_2 and B_2 by the equation

$$Y_1 = lR_2 + mG_2 + nB_2 \tag{1}$$

where l, m and n are the luminosity coefficients of the red, green and blue primaries respectively (note that $l + m + n = 1$).

Relationships have been obtained by Geddes[1] between the signal-to-noise ratio of a gamma-corrected video signal and the corresponding subjective noise visibility in the displayed picture. These relationships may be used (see assumption (i), Section 1) to express the results obtained from calculations involving the model display in terms of subjective grade values. The signal Y_1, defined by Equation (1), represents the luminance of the display and the screen of a 'linear' c.r.t. would therefore adopt a corresponding luminance value when supplied with this signal. If this 'linear' c.r.t. is assumed to consist of a conventional c.r.t. (T) having a power-law transfer characteristic, preceded by a 'gamma-correcting' circuit having a transfer characteristic exactly matching that of the tube (Fig. 1), the magnitude of the gamma-corrected signal appearing at point I (the input of the conventional c.r.t.) may be applied to Geddes' relationships to obtain the corresponding subjective grade value. The precise characteristic of the cathode-ray tube used in obtaining these relationships is not stated in Reference 1: however, in other work[2] by the same author, using the same picture-display equipment, the index of the power-law transfer characteristic is given as 2·3 (see Fig. 2 of Reference 2). The effect of the gamma-correcting circuit C (Fig. 1) may therefore be expressed as:

$$Y_2 = Y_1^{\frac{1}{2\cdot 3}} \tag{2}$$

* For primaries having the chromaticities of the three phosphors, and with peak white having a luminance of unity.

where Y_1 is the input to circuit C

and Y_2 is the output of circuit C (i.e. the signal appearing at point I in Fig. 1).

Geddes' relationships are reproduced in Fig. 2 for the cases of flat and triangular noise spectra (full and dashed lines respectively) using a 625-line display and a video bandwidth of 5 MHz. Relationships for flat noise and video bandwidths of 1 MHz and 2 MHz are also shown (chain-dotted lines): they have been derived from the 5 MHz results on the assumption* (due to Mertz[3]) that the subjective visibility of flat noise depends upon the noise power per unit bandwidth but is independent of the bandwidth itself, and could be useful when considering cross-colour noise (see Section 5) or noise from the colouring channels of a four-tube camera. When the signal-to-noise ratio at the point I in Fig. 1 has been calculated, the corresponding subjective grade of noise visibility can be deduced from Fig. 2 for any noise and signal input condition. Geddes' relations in Fig. 2 are 'average' results, obtained using a test picture containing many relatively large areas at different brightness levels. It is therefore essential to calculate a subjective grade value for each of a number of signal-input conditions (see also Section 3 and the Appendix) and obtain an overall result by averaging or otherwise combining these individual results.

3. Properties of the colour display model

Consider the effect of the presence of two noise signals of identical spectra** at the point I in Fig. 1. If these two signals have equal root – mean – square (r.m.s.) magnitudes n, their combined effect will be the same as that of a single noise signal of magnitude $\sqrt{2}\cdot n$ if the original noise signals are incoherent, and of a single noise signal of magnitude $2n$ if the original noise signals are coherent and in-phase. The two noise signals will have reached the point I by the initial application of the two signals (either singly or in combination) to the three input terminals shown in Fig. 1. If such signals were applied to a practical colour display the principal effect would be to produce fluctuations in luminance and it is therefore likely (see assumption (ii), Section 1) that the behaviour of the model described above represents, to a reasonable degree of approximation, the actual behaviour that would be obtained in practice.

If the two equal noise signals at the point I (Fig. 1) are coherent and in antiphase they will cancel completely. This behaviour of the model is less representative*** of the effect obtained in practice, as compared with the previously-discussed cases, since it is known that fluctuations in chromaticity are by no means invisible. Hacking[4] has suggested that, on average, fluctuations of chromaticity confer an advantage of 6·4 dB in signal-to-noise ratio relative

* This observation is quoted by Geddes in Reference 1.

** Such identity of spectra will be assumed throughout this discussion.

*** It is assumed that the two signals have reached the point I from different inputs. The case in which the two signals are present at the same input is trivial, since complete cancellation will occur at the input.

to fluctuations of luminance (this value has been obtained by averaging the last two rows in Table 1 of Reference 4). This implies that if two coherent and in-phase noise signals of equal magnitude are present at the point I, and the phase of one of these signals is inverted, then the effect of this inversion would be the same as retaining the in-phase condition but reducing the magnitude of both signals by 6·4 dB (i.e. multiplying their magnitudes by a linear factor of 0·48). The effect of the two antiphase and coherent noise signals of equal r.m.s. magnitude n, present at the point I, can thus be taken as being the same as that of a single noise signal of magnitude 0·96 n. This assumption represents a departure from the straightforward 'electrical' model shown in Fig. 1.

Now consider the case in which the two noise signals reaching the point I have unequal r.m.s. magnitudes n_1, and n_2 ($n_1 > n_2$). If the signals are incoherent, or coherent and in-phase, the magnitude of the resultant signal may be obtained by root-sum-of-squares or arithmetical addition respectively. In the case of antiphase coherent signals the effective 'resultant' may be found by considering the greater noise signal (magnitude n_1) as being made up of two coherent in-phase components of magnitude n_2 and ($n_1 - n_2$). Three coherent signals are thus present at the point I, two being in antiphase and of equal magnitude n_2 (and thus being replaceable by a single signal of magnitude 0·96 n_2) and the third, of magnitude ($n_1 - n_2$), being in phase with one of these equal-magnitude components. The magnitude of the effective 'resultant' (n_T) is thus

$$n_T = 0{\cdot}96 n_2 + (n_1 - n_2) \qquad (3a)$$

$$= n_1 - 0{\cdot}04 n_2 \qquad (3b)$$

The first term in Equation (3a) represents a random fluctuation of chromaticity, while the second term represents a random fluctuation of luminance. Equation (3b) has been obtained on the assumption (based on the fact that these two random fluctuations are coherent) that the two terms in Equation (3a) may be added arithmetically.* It can be seen that the magnitude of the 'resultant' is very nearly equal to that of the larger of the original noise signals and within the limits of accuracy claimed for the colour-display model equality between these two quantities may be assumed. The following proposition can therefore be stated:

> "The effect of two antiphase coherent noise signals present** at the point I in Fig. 1 may be taken as being the same as the effect of the greater of the signals taken on its own."

It must be remembered that chromaticity perturbations along particular colour axes may confer more or less advantage in noise visibility than the average value of 6·4 dB assumed in the foregoing discussion: the proposition stated above is therefore only valid when an average value of noise visibility is calculated, from the properties of the colour-display model, over an assembly of widely-differing test conditions (see also Section 2 and the Appendix). Furthermore, if the noise calculations are directed towards finding conditions for which the displayed effect of the noise is imperceptible or just perceptible, the average advantage of chromatic perturbation (relative to luminance perturbation) becomes 7·5 dB*** and Equation (3b) becomes

$$n_T = n_1 - 0{\cdot}16 n_2 \qquad (3c)$$

The neglect of the n_2 term in Equation (3c) represents a worse approximation than the neglect of this term in Equation (3b). The error involved is still likely to be relatively unimportant, but it may be thought preferable to use Equation (3c) when low noise levels are involved.

4. Summary of method of calculation of average grade of noise visibility

The calculation of the effective noise signal at the point I in Fig. 1, and hence (from Fig. 2) the grade of noise visibility, proceeds for each test condition as follows:

(1) For each input terminal, calculate the magnitude and sign of the noise signal from each noise source. At this stage the identity of the noise signals from differing sources, appearing at any one input terminal, must be preserved.

(2) For each noise signal found in Stage 1 above, calculate the signal magnitude and sign at point I, using the following parameters:
   (i) an index value in the equations describing the characteristics of the power-law circuits P_R, P_G and P_B appropriate to the display tube under consideration.
   (ii) luminosity coefficients in Equation (1) appropriate to the phosphors of the display tube under consideration
   (iii) the transfer characteristic of the gamma-correcting circuit C, using Equation (2).

(3) For one noise source, obtain totals of all positive (in-phase) and negative (antiphase) signal components at point I. (In this context signal polarity may be defined relative to the signal at the noise source itself.)

(4) Select the larger component (ignoring sign) obtained in Stage 3 as the total contribution of the noise source under consideration (or alternatively use Equation (3c) if low noise levels are involved).

(5) Repeat Stages 3 and 4 for all other noise sources.

(6) Obtain the total noise signal appearing at point I by root-sum-of-squares addition of all individual noise contributions as calculated in steps 3 to 5.

(7) Obtain the grade of noise visibility from Fig. 2.

* It is arguable that perturbations of two such different sensations as chromaticity and luminance might not add in a strictly arithmetic manner, even if these perturbations were coherent.

** See second footnote on page 3

*** The average value of 6·4 dB previously discussed includes both the 'just perceptible' and 'definitely perceptible' conditions mentioned in Table 1 of Reference 4.

This procedure is repeated for each test condition and the average value of grade of noise visibility is finally taken. It is important to remember (see Sections 2 and 3) that consideration of the grade of noise visibility for individual test conditions may be misleading. A set of test colours (based on a set often used for evaluating the colorimetric performance of colour television systems) is given in the Appendix.

If the reception of a coded colour television signal is considered, it must be remembered that 'cross-colour' noise components* will be present at the input terminals of the colour display, in addition to the original picture-source and receiver noise components. The cross-colour noise will not be coherent with any of the other noise components and will have a relatively narrow bandwidth compared with the full system bandwidth.

5. A worked example of the calculation

5.1. Statement of the problem

As an example of the calculation described above, the effect of cross-colour noise in the 625-line System I colour transmission system[5] will be considered, noise signals other than those due to cross-colour effects being ignored. In this transmission system a luminance signal (L) and two colour-difference signals (U and V) are formed from the gamma-corrected red, green and blue colour-separation signals (R', G' and B') according to the matrix equation

$$\begin{bmatrix} L \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0{\cdot}299 & 0{\cdot}587 & 0{\cdot}114 \\ -0{\cdot}147 & -0{\cdot}289 & 0{\cdot}437 \\ 0{\cdot}615 & -0{\cdot}515 & -0{\cdot}100 \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \qquad (4)$$

The luminance signal is transmitted with the full system bandwidth, while the colour-difference signals are restricted in bandwidth and used to modulate, in quadrature, a subcarrier which is superimposed on the luminance signal. At the receiver the subcarrier is separated from the luminance signal by filter circuits and demodulated to recover the signals U and V: these are then used to regenerate the colour-separation signals R' G' and B' according to the matrix equation

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1{\cdot}140 \\ 1 & -0{\cdot}394 & -0{\cdot}581 \\ 1 & 2{\cdot}020 & 0 \end{bmatrix} \begin{bmatrix} L \\ U \\ V \end{bmatrix} \qquad (5)$$

Equations (4) and (5) assume that the same signal normalisation has been applied to the colour separation signals in both the transmitter and the receiver, and in the calculations which follow it is assumed that this normalisation is such that $R' = G' = B' = 1$ volt (peak-to-peak excursion) for white. Thus in the case of these signals, and of all the signals appearing in the colour display model (Fig. 1) the signal-to-noise ratio in decibels (S) is given by the expression

$$S = 20 \log_{10} \frac{1000}{n} \qquad (6)$$

where n is the r.m.s. noise signal expressed in millivolts. It should be noted that Equation (6) is, by convention, used when specifying the noise component of a colour-difference signal, even though these signals do not themselves take the value of 1 volt under the stated normalisation conditions (in fact, it can be seen from Equation (4) that $U = V = 0$ under these conditions). It should also be remembered that as the two colour-difference signals are obtained by synchronous demodulation of the subcarrier along two mutually orthogonal axes, the cross-colour noise signals in the two signals are equal in magnitude but incoherent.

In the detailed description of the calculation given in Sections 5.2 – 5.5, the following conditions are assumed to apply:—

(a) Signal-to-noise ratio of each colour-difference signal after demodulation . . . . 34 dB

(b) Bandwidth of each colour-difference channel. . 1 MHz

(c) Colour appearing on display No.15*

(d) Value of index in equation describing transfer characteristic of display . . . . 2·8

(e) Luminosity coefficients of display** . . Red 0·222, Green 0·707, Blue 0·071

5.2. Calculation of effective gains of non-linear circuits

For a circuit having a power-law transfer characteristic, where the input (E_{in}) and output (E_{out}) signals bear the relationship

$$E_{out} = (E_{in})^{\gamma} \qquad (7)$$

the effective gain μ (for small signals) is given by

$$\mu = \gamma \cdot \frac{E_{out}}{E_{in}} \qquad (8)$$

As the outputs of the power-law circuits P_R, P_G and P_B (Fig. 1) represent the display tristimulus values, and as the phosphors assumed for the compilation of Table 1 in the Appendix are identical to those specified in the display (condition (e), Section 5.1), the output signals (R_2 G_2 and B_2) from the power-law circuits will adopt the appropriate 'linear colour-separation signal' values shown in Table 1 for the colour under consideration: adopting the normalisation that signals take the value of one volt for white, the values for colour 15 (condition (c), Section 5.1) become:—

$$R_2 = 0{\cdot}4930 \text{ v}$$
$$G_2 = 0{\cdot}0742 \text{ v}$$
$$B_2 = 0{\cdot}2135 \text{ v}$$

Since knowledge of the magnitude of either the output signal or the input signal of a given power-law circuit defines

* Noise components resulting from the demodulation of luminance-channel noise components falling within the pass-bands of the chrominance channels, resulting in a downwards frequency translation of the original noise spectrum.

* See Appendix, Table 1.

** As appropriate to the phosphors specified for the System I transmissions.

the operating point on its transfer characteristic and thus enables its effective gain to be calculated from Equations (7) and (8), the gains of the power-law circuits P_R, P_G and P_B become, using conditions (c) and (d), Section 5.1.

$$\text{Gain of } P_R = 1{\cdot}777$$
$$\text{Gain of } P_G = 0{\cdot}526$$
$$\text{Gain of } P_B = 1{\cdot}038$$

Furthermore from condition (e), Section 5.1, Equation (1) (Section 2) may be written as

$$Y_1 = 0{\cdot}222R_2 + 0{\cdot}707G_2 = 0{\cdot}071B_2 \qquad (1a)$$

and therefore, for colour No. 15,

$$Y_1 = (0{\cdot}222 \times 0{\cdot}4930) + (0{\cdot}707 \times 0{\cdot}0742) +$$
$$+ (0{\cdot}071 \times 0{\cdot}2135) = 0{\cdot}1770 \text{ v}$$

Hence the gain of the gamma-correcting circuit C in Fig. 1 may be calculated from Equations (2), (7) and (8) and it is found that:—

$$\text{Gain of C} = 1{\cdot}157$$

5.3. Calculation of noise contribution from the U-signal channel

Now that the gains of the non-linear circuits have been established for the test colour under consideration, the calculation of the noise-signal magnitudes may proceed. It is first noted that, from condition (a), Section 5.1, and by use of Equation (6), the noise signal associated with each colour-difference signals has the magnitude of 20 millivolts. The noise signal originating in the U-signal channel can therefore be seen, from Equation (5),* to contribute to the noise signal at each input to the display as follows:—

Red channel	No contribution
Green channel	Negative contribution of magnitude 20 x 0·394 = 7·88 mV
Blue channel	Positive contribution of magnitude 20 x 2·020 = 40·40 mV

The terms 'positive' and 'negative' refer to the phase of the appropriate noise signals relative to the original noise signal present in the U-signal channel, as described in Paragraph (3) of Section 4. After passing through the power-law circuits, the above magnitudes of the U-channel noise-signal contributions are multiplied by the appropriate circuit gain factors (see Section 5.2) and become:—

Red channel	0 x 1·777 = 0 mV
Green channel	7·88 x 0·526 = 4·14 mV (negative)
Blue channel	40·40 x 1·038 = 41·94 mV (positive)

* The red colour-separation signal R' in Equation (5) corresponds to the signal R_1 in Fig. 1: the green and blue signals similarly correspond.

These noise-signal contributions are then applied to the inputs of the combining circuit M (Fig. 1), and the magnitudes of the contributions appearing at the output of this circuit are obtained by multiplying each input signal magnitude by the appropriate coefficient in Equation (1a); this gives

Contribution from Red channel	0 x 0·222 = 0 mV
Contribution from Green channel	4·14 x 0·707 = 2·93 mV (negative)
Contribution from Blue channel	41·94 x 0·071 = 2·98 mV (positive)

At this stage the separate total of all positive and all negative contributions from the U-channel noise signal can be obtained and the larger component (ignoring sign) selected, as detailed in Paragraphs (3) and (4) of Section 4. In the present example only one positive and one negative contribution is present and the numerically larger of these contributions is therefore taken as the final U-channel noise signal contribution: thus

U-channel noise signal contribution at output of combining circuit M = 2·98 mV

5.4. Calculation of noise contribution from the V-signal channel

The calculation of the V-channel noise-signal contribution follows the method described for the U-channel noise signal in Section 5.3. The contributions of V-channel noise signal at each input to the display are, from Equation (5):—

Red channel	Positive contribution of magnitude 20 x 1·14 = 22·80 mV
Green channel	Negative contribution of magnitude 20 x 0·581 = 11·62 mV
Blue channel	No contribution

Thus at the output of combining circuit M

Contribution from Red channel	= 9·00 mV (positive)
Contribution from Green channel	= 4·32 mV (negative)
Contribution from Blue channel	= 0 mV

As in the case of the U-channel noise signal, only one positive and one negative contribution is present. Taking the larger of these contributions:—

V-channel noise-signal contribution at output of combining circuit M = 9·00 mV

5.5. Calculation of subjective grade of noise visibility

Because the noise signals derived from the U and V colour-difference signal channels are incoherent, the overall noise signal appearing at the output of combining circuit M (Fig. 1) is obtained by taking a root-sum-of-squares addition of the two individual contributions. Thus:—

Overall noise signal at output of combining circuit M = $[(2{\cdot}98)^2 + (9{\cdot}00)^2]^{½} = 9{\cdot}48$ mV

The noise signal now passes through the gamma-correcting circuit C and its magnitude is therefore multiplied by the gain factor of this circuit (see Section 5.2). Thus

Overall noise signal at point I (Fig. 1) =
$9{\cdot}48 \times 1{\cdot}157 = 10{\cdot}96$ mV

Expressing this result in decibels, using Equation (6):—

Overall noise signal at point I = 39·2 dB

Hence from Fig. 2, using the curve for a signal bandwidth of 1 MHz (see condition (b), Section 5.1):—

Grade of noise visibility = 3·3

5.6. Discussion

It will have been noticed that in Sections 5.3 — 5.5 the process (detailed in Paragraphs (3) — (6) of Section 4) of calculating an overall noise-signal magnitude from the individual noise components has been carried out at the output of the combining circuit M (Fig. 1) instead of at the point I, as stated in Section 4. The two methods of calculation lead to identical results: the specification in Section 4 of the point I as the 'combining point' for the individual noise signals was made purely for descriptive convenience.

In the foregoing worked example the magnitudes of the signals R_2 G_2 and B_2 at the outputs of the power-law circuits (Fig. 1) were specified, thus enabling the effective gains of these circuits and also that of the gamma-correcting circuit to be calculated. It may sometimes be convenient to specify instead the magnitudes of the signals R_1 G_1 and B_1 at the inputs to the power-law circuits.

Because of the necessity (see Sections 2 and 3) for calculating the grade of noise visibility for each of a number of test colours, the calculation is most conveniently carried out by computer. Probably these calculations would be incorporated in a programme which also derived the initially-required video- and noise-signal magnitudes from a knowledge of the operating conditions and circuit functions of the equipment under consideration.

6. References

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3. MERTZ, P. 1949. Perception of television random noise. *J. Soc. Motion Pict. Telev. Engrs.*, 1950, **54**, 1, pp. 8 — 34.
4. Colorimetric analysis of interference in colour television. BBC Research Department Report No. T-160, Serial No. 1966/5.
5. Specification of television standards for 625-line system-I transmissions. Published jointly by the BBC and the ITA, January 1971.

APPENDIX

The 26 test colours shown in Table 1 are based on a set of test colours often used for evaluating the colorimetric performance of colour television cameras. The original colours are defined in terms of their spectral reflectance characteristics, and the linear colour-separation signals (R, G, B) shown in the table correspond with the theoretically 'ideal' conditions in which the colours are illuminated by Illuminant D_{65}, the white-point of the display has the chromaticity of Illuminant D_{65}, and the colour camera producing the colour-separation signals has in each colour channel the analysis characteristic appropriate to the display phosphors specified for the 625-line System I Transmissions.[5] Some of the saturated colours (indicated by an asterisk in the table) are outside the gamut of colours obtainable with the System I phosphors: In this case the output of the appropriate colour channel has been taken as zero (rather than the theoretically-required negative value) and the chromaticity of the displayed colour is not exactly the same as that of the colour in the original scene.

TABLE 1

Set of Test Colours
(See text for assumed colorimetric parameters)

Colour		Linear Colour-Separation Signals (%)			Displayed Chromaticity Co-ordinates		Displayed Luminance %
Type	No.	*R*	*G*	*B*	u	v	
Saturated	1	3·45	1·97	35·16	0·1886	0·1568	4·66
	2	0·07	40·33	64·71	0·1408	0·2759	33·14
	3*	0·00	48·77	2·24	0·1219	0·3696	34·66
	4*	77·85	70·99	0·00	0·2098	0·3672	67·46
	5*	92·35	11·44	0·00	0·3620	0·3557	28·55
	6*	72·22	0·77	0·00	0·4408	0·3497	16·54
	7	89·35	3·23	23·29	0·3700	0·3020	23·73
	8	43·98	0·20	41·48	0·3113	0·2276	12·83
Desaturated	9	27·15	27·30	65·76	0·1924	0·2646	30·00
	10	36·75	61·95	67·39	0·1756	0·3049	56·75
	11	31·69	51·72	18·30	0·1771	0·3446	44·91
	12	65·49	63·03	9·72	0·2051	0·3572	59·79
	13	82·20	37·58	15·10	0·2541	0·3436	45·86
	14	48·09	8·33	8·11	0·3213	0·3307	17·12
	15	49·30	7·42	21·35	0·3068	0·2959	17·69
	16	62·88	22·73	67·19	0·2427	0·2709	34·78
Skin Tones	17	59·90	40·42	30·67	0·2221	0·3256	44·04
	18	54·93	35·81	26·09	0·2246	0·3272	39·36
	19	48·35	30·55	18·44	0·2280	0·3331	33·63
	20	31·75	18·96	11·24	0·2320	0·3339	21·24
	21	19·44	10·28	6·92	0·2397	0·3310	12·07
	22	9·38	6·32	4·76	0·2223	0·3259	6·88
	23	50·20	28·87	21·21	0·2330	0·3278	33·05
	24	46·49	24·77	19·68	0·2376	0·3258	29·22
Foliage	25	17·80	26·32	11·51	0·1813	0·3394	23·38
	26	4·83	7·30	4·56	0·1801	0·3285	6·56
White		100·00	100·00	100·00	0·1978	0·3122	100·00

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